Experiments to Improve Power Conversion Paramters in a TWDEC Simulator

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Traveling Wave Direct Energy Converter (TWDEC) is used for efficient energy conversion of high energy protons produced in an advanced fusion (D-^{3}He) reactor. The authors are continuing experimental research to realize TWDECs.

In a TWDEC, a fast proton beam is introduced in a modulator where the beam is velocity-modulated. The beam is density-modulated in the downstream where a decelerator is settled and the modulation frequency is induced on aligned electrodes. The electrodes are connected to an external circuit, and current flows in the circuit forms a traveling voltage on the electrodes, and thus, a deceleration field between the electrodes. The beam is decelerated by this field. In order to examine a desirable structure of the decelerator, the authors are continuing simulation experiments in two ways. One is for formation of deceleration fields, and we call this working mode as a passive decelerator. The other is for deceleration of an ion beam, and we call as an active decelerator. In this paper, we will present improved results of each working mode.

As for the passive decelerator, it is required to create a strong deceleration field. For this purpose, we introduced a new type of external circuit, which we called as loop type. We had used a line type external circuit before, the ends of which were terminated by matched resisters and an induced power was consumed by the resisters. In the new circuit, both ends are connected to each other and there are no resisters. The induced power is consumed by just small resistive components of inductors, thus voltages on electrodes are expected to be higher.

We actually constructed a loop type external circuit, and obtained results that the excited voltage was higher in an order of magnitude. The results also indicated a problem that higher harmonic frequencies were excited as a Q-value of the circuit was high. We are continuing works to suppress them.

As for the active decelerator, we seek for a desirable structure of decelerator electrodes. The beam current of our TWDEC simulator is rather small, so the deceleration field created by the passive decelerator is weak. We have performed experiments creating a deceleration field by using an external power source.

We had examined variation of deceleration efficiency, which directly equaled to recovery efficiency of ion energy. We obtained a conclusion: the deceleration efficiency saturated when the phase velocity of traveling wave was constant, but it extended beyond the saturation level when we varied the phase velocity to match with the decelerated beam velocity. We have proved this effect in principle by adjusting the phase difference of voltage between electrodes. In a real TWDEC, this is realized by adjusting distances between electrodes. We are now performing experiments to adopt this scheme to obtain the best deceleration efficiency. The details will be presented in the meeting.